

0 5 10 15 20 25 KILOMETERS

MAP OF THE UNALAKLEET QUADRANGLE SHOWING LOCATION OF FIELD OBSERVATION POINTS (DOTS) AND CONTINUOUS FOOT TRAVERSES (LINES) Geology extended between field stations by aerial reconnaissance and by interpretation of aerial photographs. Surficial deposits mapped almost entirely from

Unconformity Oligocene Unconformity Unconformity Unconformity Lower Cretaceous Unconformity Upper and Middle Jurassic

CORRELATION OF MAP UNITS

## DESCRIPTION OF MAP UNITS

- FLOOD-PLAIN DEPOSITS (HOLOCENE) -- Silt, sand, and gravel along flood plains of stream valleys. Light-gray micaceous silt along Yukon River; chiefly sand and gravel along Unalakleet River and small streams that drain bedrock uplands. Characterized physiographically by bars, oxbow lakes, meander scrolls, abandoned channels and other evidence of recent flood-plain
- FLUVIAL, COLLUVIAL, AND EOLIAN TERRACE AND SLOPE DEPOSITS, UNDIVIDED (HOLOCENE AND PLEISTOCENE) -- Chiefly silt and very fine sand. Terrace deposits appear to be largely fluvial; slope deposits probably include both colluvial and eolian deposits. Characterized locally by thermokarst topography with many small thaw lakes. Mapped almost entirely from aerial photographs

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- YOUNGER BASALT FLOWS AND CONES (HOLOCENE) -- Fresh unmodified basalt flows and cones in the vicinity of The Sisters. Covered by little vegetation and probably not more than a few thousand years
- OLDER BASALT FLOWS AND CONES (PLEISTOCENE) -- Nearly horizontal columnar-jointed flows of fine-grained, black or gray vesicular porphyritic tholeiite and alkali olivine basalt. Flows have a total thickness of at least 100 m along Golsovia River. Thinly covered by silt and tundra vegetation. Tholeiite composed of roundmass of either plagioclase, pyroxene and interstitial glass, or sparse plagioclase microlites in glass. Cones are composites of cinders, breccia, and short flows. Some cones composed of alkali basalt which locally may include basanite (Hoaré and Condon, 1971). Alkali basalt is mostly fine grained porphyritic, black or gray, dense or finely vesicular. Consists of olivine, plagioclase, and subordinate clinopyroxene and magnetite phenocrysts in a subophitic or diktytaxitic groundmass. Peridotite xenoliths locally abundant in alkalic Assigned a Quaternary age by Hoare and Condon (1971) in the adjoining St. Michael quadrangle based on physiographic expression of flows and cones and on geomagnetic polarity measurements which suggest that they were erupted during the Matuyama Reversed Chron (2.4 m.y. to 0.7 m.y.) and the present-
- Ts CLAY SHALE AND COAL (MIOCENE OR OLIGOCENE) -- Poorly consolidated deposits of gray to brown clay shale, lignitic coal, and yellow volcanic ash mapped only in low beach exposures about 15 km south of Unalakleet. Thickness of section appears to be about 10 m but exposures are badly slumped. Unit assigned an early Miocene or late Oligocene (Seldovian) age based on pollen and spore

day Brunhes Normal Chron. Unit mapped largely from aerial

- assemblages from lignite (Estella Leopold, written commun., 1966) QUARTZ MONZONITE (EOCENE AND PALEOCENE) -- Stock of pink to light-gray fine-grained quartz monzonite and quartz monzodiorite intruding volcanic rocks of early Tertiary age along axis of Blackburn syncline. Composed of a hypidiomorphic granular or sparsely porphyritic aggregate of pink to gray orthoclase, white oligoclase and andesine, quartz, and dark grains of amphibole, biotite, and opaque minerals. Plagioclase crystals commonly mantled by thick rims of orthoclase. Apatite and zircon are common accessories. Assigned an Eocene and Paleocene age based on a potassium-argon age of 56.2+1.7 m.y. obtained from a biotite
- RHYOLITE TUFF (EOCENE AND PALEOCENE) -- More than 750 m of rhyolitic tuff and breccia exposed along axis and northwest flank of the Blackburn syncline. Composed chiefly of green tuff and breccia containing clasts as much as 30 cm in diameter of flow-banded perlitic rhyolite, green pumice, and rare andesite in a matrix of devitrified glass shards and crystals of altered feldspar and mafic minerals. Rhyolite breccia composed of angular clasts of white flow-banded devitrified rhyolite. Intercalated with highly altered andesite flows and cut by fine-grained pink dacite dikes. Unit believed to represent intracaldera tuff. Assigned an Eocene and Paleocene age. Unit is younger than andesite and basalt flows (Ta) through which it is extruded and older than

quartz monzonite (Tq) which intrudes it

RHYOLITE AND RHYODACITE DOMES (EOCENE AND PALEOCENE) -- Well-exposed rhyolite and rhyodacite domes and associated basal breccia and tuff mainly along northwest flank and axis of Blackburn syncline. Rhyolite composed of sparse phenocrysts of euhedral anorthoclase and bright-green pyroxene in a groundmass of flowbanded perlitic glass or devitrified glass. Rhyodacite composed of 7 to 10 percent phenocrysts of zoned andesine and oligoclase and various mafic minerals including clinopyroxene, orthopyroxene, hornblende, biotite, and opaque minerals in a groundmass consisting either of devitrified glass or of sparse plagioclase microlites in brown glass. Abundant secondary chalcedony. Breccia and tuff composed of rhyolite and perlitic glass clasts, altered pumice, glass shards, and feldspar and quartz crystals. Unit assigned an Eocene and Paleocene age. Locally intercalated with upper part of the andesite and basalt flows unit (Ta). May be correlative in part with the rhyolite tuff unit (Tr) and in part with the quartz monzonite unit (Tq). A sanidine mineral separate from a rhyolite dome sample gave a

potassium-argon age of 56.0+1.7 m.y. (table 2)

- ANDESITE AND BASALT FLOWS (EOCENE AND PALEOCENE) -- Well-exposed sequence more than 1,000 m thick of subaerial columnar-jointed andesite and basalt flows in the Blackburn syncline. The most common rock type is a sparsely porphyritic pyroxene andesite with fine-grained phenocrysts of plagioclase, clinopyroxene, and subordinate orthopyroxene set in a groundmass of plagioclase microlites, granular pyroxene, and dark glass. Other rock types in this unit include olivine basalt and high-silica hornblende andesite. A hornblende mineral separate from an andesite flow from near the base of the unit yielded a potassium-argon age of 65.2+3.9 m.y. (table 2). Top of unit locally intercalated with the rhyolite and rhyodacite domes unit (Td). Assigned an Eocene
- FELSIC VOLCANIC AND HYPABYSSAL ROCKS, UNDIFFERENTIATED (EOCENE AND PALEOCENE) -- Unit consists of a variety of domes, flows, tuffs, breccias, and fine-grained hypabyssal rocks of rhyolitic to dacitic composition widely distributed in the eastern and central parts of the quadrangle. Subordinate andesite and basalt flows and volcaniclastic rocks locally included within this unit. Domes and flows typically consist of light-tan rhyolite with phenocrysts of plagioclase, embayed quartz, and sanidine in an altered groundmass of quartz and feldspar. A well-exposed unaltered dome at Eagle Slide on the Yukon River is composed of white flow-banded perlitic and devitrified glass with phenocrysts of quartz, plagioclase, anorthoclase, sanidine, biotite, and hornblende. Rhyolite tuff and breccia commonly occur at the bases of the domes. Also included within this unit are swarms of sills, dikes, and plugs of dacite porphyry, only the largest of which are shown on the map. These rocks pervasively intrude the sandstone, shale, conglomerate, and coal unit (Ks), the volcanic graywacke and mudstone unit (Kg), and the andesitic volcaniclastic rocks unit (Kv). Typically the porphyry consists of altered phenocrysts of plagioclase, hornblende, biotite, and occasionally quartz in an altered groundmass of quartz, feldspar, chlorite, zoisite, calcite, and sericite. A potassium-argon age of 53.2+1.6 m.y. was obtained from a sanidine mineral separate from rhyolite dome at Eagle Slide (table 2). Felsic tuffs and breccias on the east side of the Chiroskey fault zone underlie an olivine basalt flow of the undifferentiated mafic volcanic rocks unit (Tm) which gave a whole-rock potassium-argon age of 61.5+1.8 m.y. (table 2). Unit assigned an Eocene and Paleocene age
- MAFIC VOLCANIC ROCKS, UNDIFFERENTIATED (EOCENE AND PALEOCENE) -- Unit consists of a wide variety of mafic flows and volcaniclastic rocks scattered across the eastern and central parts of the quadrangle. Common rock types include olivine basalt and pyroxene andesite flows and andesitic and basaltic agglomerate, coarse breccia, and fine-grained tuffs. All these rocks are assigned an Eocene and Paleocene age. An olivine basalt flow from the east side of the Chiroskey fault zone yielded a wholerock potassium-argon age of 61.5+1.8 m.y. and an andesite porphyry from a dissected cone located between the Yukon River and Bear Creek gave a whole-rock potassium-argon age of 53.8+1.6 m.y. (table 2)
- SANDSTONE, SHALE, CONGLOMERATE, AND COAL (UPPER AND LOWER CRETACEOUS) -- Chiefly fluvial and shallow-marine deposits of wellsorted medium- to coarse-grained light-gray to olive crossbedded sandstone, fine- to medium-grained dark-gray to green silty sandstone, dark-gray micaceous shale, quartz-chert pebble conglomerate, and thin seams of bituminous coal. Unit best exposed in sea cliffs south of Unalakleet, in cutbanks along the Chiroskey and Anvik Rivers, and in the west bank of the Yukon River. Sandstones composed chiefly of quartz, chert, and metamorphic rock detritus with subordinate amounts of volcanic rock fragments and plagioclase. Bituminous coal seams generally less than 50 cm thick; a 1-m-thick coal seam reported on Yukon River at the Williams mine 6 km upstream from Eagle Slide, and a 75- to 90-cm-thick seam reported 20 km upstream from Blackburn (Chapman, 1963). On South River unit includes some hard fine- to medium-grained sandstone turbidites and mudstone of uncertain affinity. Unit assigned a late Early (Albian) and early Late (Cenomanian) Cretaceous age. Marine mollusks of mid-Albian to early Cenomanian age, including Turrilites acutus Passy, Gastroplites kingi, Grantziceras sp., and Inoceramus sp. (D. L. Jones, written commun., 1959, 1963, 1969), found along Chiroskey and Anvik Rivers, in the Old Woman River drainage, and in the uplands between the Unalakleet and North Rivers. Fossil freshand brackish-water mollusks common throughout quadrangle. Abundant plant fossils of probable Cenomanian age (R. A. Spicer, written commun., 1981) consist of both conifers and angiosperms. Unit unconformably overlies the andesitic volcaniclastic rocks unit (Kv), trachyandesite and trachybasalt tuffs and flows unit (Kt), and volcanic graywacke and mudstone unit (Kg). Distinguished from the clastic rocks in these units by better sorting and by the predominance of quartz and metamorphic rock fragments over volcanic rock detritus. Total thickness of unit uncertain but probably exceeds 1,000 m
- VOLCANIC GRAYWACKE AND MUDSTONE (LOWER CRETACEOUS) -- Dark-gray to green hard fine-grained to conglomeratic volcanic graywacke, and dark-gray finely laminated mudstone. Best exposed in sea cliffs north of Unalakleet; elsewhere exposures are largely reduced to frost-riven rubble. Comprises a turbidite assemblage consisting of submarine fan deposits, chiefly of midfan channel and related overbank facies (Nilsen and Patton, 1984). Graywacke composed largely of intermediate and mafic volcanic rock detritus and chert, with subordinate quartz and metamorphic and plutonic rock debris. Unit appears transitional in composition between the andesitic volcaniclastic rocks unit (Kv) and the sandstone, shale, conglomerate, and coal unit (Ks). Some graywacke beds are characterized by a distinctly mottled appearance due to the presence of laumontite (Hoare and others, 1964). No fossils found in unit. Assigned an Early Cretaceous (Valanginian to mid-Albian) age based on stratigraphic position above the andesitic volcaniclastic rocks unit and below the sandstone, shale, conglomerate, and coal unit
- TRACHYANDESITE AND TRACHYBASALT TUFFS AND FLOWS (LOWER CRETACEOUS) --Dark-gray to green lapilli tuffs, pillowed flows, and volcanic conglomerate of trachyandesitic and trachybasaltic (mugearite) composition exposed on a prominent north-trending ridge near Yellow River in central part of quadrangle. Subordinate trachyte. Tuffs consist of poorly sorted medium- to coarsegrained volcanic rock fragments, crystals of plagioclase and clinopyroxene, opaque minerals, and pumice with abundant interstitial prehnite and calcite. Tuffs contain abundant glass in groundmass and clasts suggesting quench textures. Flows are composed of phenocrysts of andesine or labradorite, clinopyroxene, opaque minerals and locally biotite in a groundmass of trachytic plagioclase microlites, altered mafic

minerals (olivine?), and dark devitrified glass. Conglomerate

## MISCELLANEOUS FIELD STUDIES

composed of well-rounded cobbles of dark-reddish and greenish trachyandesite porphyry in a dark tuffaceous matrix. Unit unconformably underlies the sandstone, shale, conglomerate, and coal unit (Ks). Assigned an Early Cretaceous (Aptian or Barremian) age based on a potassium-argon age of 118+3.5 m.y. obtained from a biotite mineral separate from a trachyandesite

ANDESITIC VOLCANICLASTIC ROCKS (LOWER CRETACEOUS) -- Dark-greenishgray crystal and lithic tuffs, fine cherty tuffs, and volcanic sandstone. Exposed along a belt that extends from the upper Anvik River drainage north northeast to the Unalakleet River valley. Tuffs generally are present in cyclically repeated sequences that grade upward from coarse tuff breccia and lapilli tuff to very fine grained cherty tuff and rare blue-green radiolarian chert. Tuffs composed chiefly of fine-grained darkred and green basalt and andesite fragments, plagioclase, and mafic minerals in an altered matrix of devitrified glass. In upper part of unit tuff is commonly highly calcareous and locally contains abundant shelly debris including Buchia. Tuffs grade into volcanic sandstone which also is composed chiefly of darkred and green basalt and andesite fragments and plagioclase crystals but is better sorted and lacks abundant matrix. Tuffs locally contain plutonic rock debris of intermediate composition probably derived from the underlying trondhjemite and tonalite unit (Jt). Some altered basalt or andesite flows along Anvik River and in the vicinity of Mount McDonald. Unit unconformably overlies trondhjemite and tonalite unit (Jt) and the altered basalt and diabase unit (MzPzb). Unit assigned an Early Cretaceous (Valanginian) age. Poorly preserved fragments of <u>Buchia</u> and brachiopods found at several localities but none specifically identifiable. Well-preserved specimens of Buchia crassicolis solida of Valanginian age (Lahusen) (J. W. Miller and D. L. Jones, written commun., 1982) are present in a similar assemblage of volcaniclastic rocks in the adjoining Norton Bay quadrangle. Radiolarians of possible Early Cretaceous (Valanginian) age (D. L. Jones, B. Murchey, and C. D. Blome, written commun., 1981) found in chert along Chiroskey-Anvik

TRONDHJEMITE AND TONALITE (UPPER AND MIDDLE JURASSIC) -- Chiefly trondhjemite and tonalite with subordinate quartz diorite, diorite, and gabbro. Forms long narrow fault-bounded pluton of 50 to 60 percent oligoclase and andesine, 25-45 percent quartz, and less than 7 percent biotite. Tonalite consists of 50-55 percent plagioclase, about 20 percent quartz, 5-10 percent biotite, and 15-25 percent hornblende. Much of the trondhjemite and tonalite along the west side of the pluton has been altered by potassium metasomatism to a pink granite and granodiorite (shown on map by dot pattern). Altered rock is composed of as much as 25 percent orthoclase replacing plagioclase. In many places pluton is deformed by cataclasis and brecciation. Assigned a Middle and Late Jurassic age on the basis of a biotite mineral separate from trondhjemite which yielded a potassiumargon age of 154+6 m.y. and a biotite-hornblende mineral-pair separate from tonalite which produced potassium-argon ages of 166+7 and 173+9 m.y. (table 2)

ALTERED BASALT AND DIABASE (MESOZOIC OR PALEOZOIC) -- Dark-green to gray altered basalt and fine-grained diabase exposed along high ridge between upper Anvik and upper Chiroskey Rivers. Subordinate intercalated cherty tuff. Possible pillow structures in basalt. Basalt and diabase composed almost entirely of saussuritized weakly twinned plagioclase and fine-grained metamorphic amphibole. Relict igneous texture. Locally highly sheared and granulated. Prehnite and pumpellyite(?) identified in one sample. Age of unit uncertain; may be correlative with late Paleozoic-early Mesozoic ophiolites and allied oceanic crustal rocks exposed along margins of Yukon-Koyukuk basin (Patton and others, 1977). Unit appears to be intruded by the trondhjemite and tonalite unit (Jt) in southern part of quadrangle (J. M. Hoare, oral commun., 1981)

CONTACT--Approximate, inferred, or uncertain

FAULT--Dashed where inferred or approximately located; dotted where concealed. U, upthrown side, D, downthrown side. Arrows indicate direction of relative movement

STRIKE AND DIP OF BEDS--May include overturned beds

Based on photo-interpretation or distant observation

For chemical analysis and C.I.P.W. norms. Number refers

For potassium-argon age data. Letter refers to table 2

AREA OF POTASSIUM METASOMATISM--Where trondhjemite and tonalite unit (Jt) altered to pink granite and

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## Table 1.--Chemical analyses and Cross, Iddings, Pirsson, Washington (C.I.P.W.) norms of selected volcanic and plutonic rock samples [See map for sample localities. Measurements shown in percentage, dashed where no data. Analyses by J. S. Walberg, J. E. Taggart, Jr.,

J. W. Baker, H. G. Neiman, F. D. Newman, and G. R. Mason] 63°13.5' 63°37.5' 63°25.5' 63°22' 63°21.5' 63°26.5' 63°27.5' 63°21.5' 63°17.5' 63°16.8' 63°46.5' 63°41' 63°48' 49.10 48.40 75.10 73.10 52.10 55.50 60.40 73.0 57.10 51.0 72.40 66.50 50.30 11.0 13.90 17.30 18.20 16.70 13.90 17.60 19.60 14.20 15.0 17.20 -- .51 4.30 3.40 2.20 .20 2.42 3.30 .82 1.82 5.86 9.72 9.08 .39 .14 8.79 8.35 4.03 .69 4.23 7.18 3.02 2.15 7.71 3.30 2.90 4.60 3.90 3.20 3.30 4.60 4.0 3.60 3.20 4.03 4.96 4.05 .90 .69 4.22 4.37 1.10 1.26 2.40 3.20 5.28 4.13 1.51 2.31 1.09

K <sub>2</sub> O	.90	.69	4.22	4.37	1.10	1.26	2.40	3.20	5.28	4.13	1.51	2.31	1.09
TiO <sub>2</sub>	1.83	1.86	.25	.33	1.63	.98	.92	.28	.53	1.04	.32	.42	.99
P <sub>2</sub> O <sub>5</sub>	.34	.20			.30	.20	.40		.30	.40	.15	.14	.19
MnO	.17	.16	.07	.02	.16	.10	.04	.03	.01	.14	.06	.09	.20
H <sub>2</sub> O <sup>+</sup>	.30	.20	.24	.81	1.01	.42	1.35	1.14	1.92	1.79	.62	1.66	2.41
H <sub>2</sub> O	.02	.25	.05	.39	.57	.73	.65	.41	.42	.69	.02	.18	.33
co <sub>2</sub>		.01			.32	.19	.14	.49	2.12	.28		.90	.01
Total	100.39	99.86	99.53	99.48	99.59	99.25	99.36	99.03	100.97	99.62	99.76	99.59	100.83
SiO <sub>2</sub> anhydrous		48.69	75.68	74.38	53.33	56.48	62.13	75.27	59.17	52.65	73.04	68.66	51.28
A CAMPAGE OF THE					'								
Normative mineralogy													
q		.20	33.29	33.43	7.61	11.22	14.05	37.05	7.47		35.69	22.79	
C				2.78			0.17	2.92	3.86		.81	2.86	
or	5.30	4.06	25.07	26.23	6.61	7.58	14.57	19.46	30.87	25.10	8.94	13.71	6.3
ab	27.81	24.42	33.27	33.52	27.54	28.42	39.99	34.84	30.14	27.85	34.18	42.14	33.9
ac			5.17								-		
an	22.55	26.30	-	.04	30.09	31.67	17.86	2.85	5.56	27.68	14.04	4.08	25.3
wo	9.71	4.77	.29	-	2.98	2.54				1.30			4.7
en	7.51	22.51	.25	1.29	10.89	8.62	5.63	.51	5.96	4.06	2.05	4.55	4.4
fs	2.67								5.14		.67	3.62	3.4
fo	10.83									3.08			7.0
fa	4.25										-		6.0
mt	4.81								2.22		2.04	1.22	3.5
hm		12.84	1.86	2.11	9.61	7.10	5.80	1.80		7.46			
il	3.46	.34	.15	.04	.35	.22	.09	.07	1.0	.31	.61	.80	1.8
tn		4.10	.42		3.62	2.17				2.23			
ru				.31	-	-	.90	.25					
ap	.80	.47	.24	.24	.72	.48	.97	.24	.70	.97	.36	.33	.4
CC			-	-					4.77			2.06	.0
Total	99.70	100.01	100.01	99.99	100.02	100.02	100.03	99.99	97.69	100.04	99.39	98.16	97.3
salic	55.66	54.98	91.63	95.96	71.85	78.89	86.64	97.12	77.90	80.63	93.66	85.58	65.7
femic	44.04	45.03	8.38	4.03	28.17	21.13	13.39	2.87	19.79	19.41	95.73	12.58	31.6

Olivine tholeiitic basalt flow Quartz tholeiitic basalt flow Anorthoclase-pyroxene rhyolite dome 4 Plagioclase-biotite rhyodacite dome 5 Olivine-bearing basalt flow

6 Orthopyroxene andesite flow 7 Hornblende andesite flow 8 Rhyolite dome 9 Trachyandesite flow

10 Trachybasalt flow

ll Trondhjemite 12 Trondhjemite 13 Amphibole diorite Table 2.--Potassium-argon age determinations

[See map for sample localities.  $^{40}$ K decay constants:  $\lambda_{\epsilon} = 0.581 \times 10^{-10} \text{ yr}^{-1}$ ;  $\lambda_{\beta} = 4.963 \times 10^{-10} \text{ yr}^{-1}$ . Abundance ratio:  $^{40}$ K/ $_{K}$  = 1.167 x 10<sup>-4</sup> atom percent. Potassium analyses by P. R. Klock and S. T. Neil; argon analyses and age calculations for samples E, F, H, and I by Krueger Enterprises, Geochron Laboratories, Cambridge, Massachusetts, and M. L. Silberman. Argon analyses and age calculations for other samples by J. Y. Saburomaru and J. C. Von Essen]

Sample Locality	Field No.	Mineral or whole rock	Map symbol	K <sub>2</sub> O (percent)	40 <sub>Arrad</sub>		40 <sub>Arrad</sub>	Calculated age	
A	80APa 330	Sanidine	Tf	5.34 5.31	4.139	x 10 <sup>-10</sup>	.66	53.2 <u>+</u> 1.6	
В	82APa 80	Andesite	Tm	1.224 1.224 1.227 1.233	9.650	x 10 <sup>-11</sup>	.89	53.8 <u>+</u> 1.6	
С	80APa 116A	Basalt	Tm	1.612 1.628 1.617 1.609	1.457	x 10 <sup>-10</sup>	.41	61.5 <u>+</u> 1.8	
D	81APa 223	Biotite	Tq	7.85	6.452	x 10 <sup>-10</sup>	.85	56.2 <u>+</u> 1.7	
E	80AM1 39d	Sanidine	Tđ	3.75 3.77	3.08	x 10 <sup>-10</sup>	.86	56.0 <u>+</u> 1.7	
F	80AMl 12B	Hornblende	Та	.668		x 10 <sup>-10</sup>	.35	65.2 <u>+</u> 3.9	
G	81APa 208	Biotite	Kt	6.91 9.96	1.219	х 10 <sup>-9</sup>	.96	118 <u>+</u> 3.5	
H	80APa 15A	Biotite	Jŧ	4.52 4.51		x 10 <sup>-10</sup>	.67 .79	154 <u>+</u> 6	
ı		Biotite  Hornblende		2.32	5.645		.70	166 <u>+</u> 7	
	80AMl 25		Jŧ	.662	1.730		.62	173 <u>+</u> 9	